Disciplinary Literacy in Grades 3-5 Science

Purpose of this Document

This document is intended to illustrate how disciplinary literacy skills develop in science and possible strategies that teachers can use while helping their students deepen their understanding of science content and practices. It is important to note that the 2016 ELA Standards are meant to complement the specific content demands of the Arizona Science Standards for grades 3-5, not replace them.

In this document, **text** is broadly defined as any communication, spoken, written, or visual, involving language. This include written words, numbers, and symbols; visual representations in graphs, pictures, flowcharts, videos, and computer simulations; information provided by reading scientific tools and instruments; published documents in print or electronic format; unpublished documents written by students, peers, or teachers; or other sources of information.

Science Sense-Making

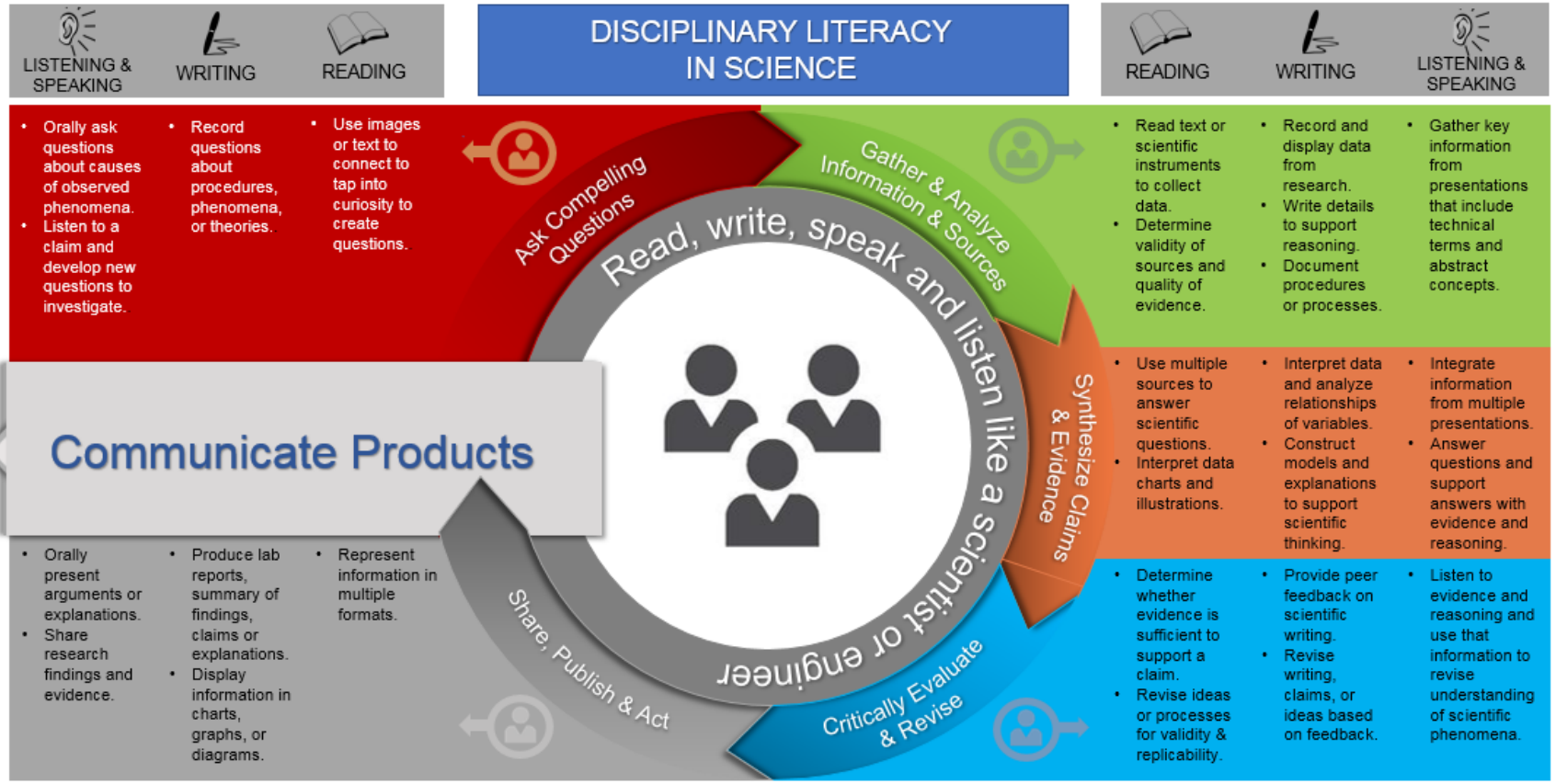
A fundamental goal of science education is to help students figure out how the world works and make sense of scientific phenomena or compelling questions. A scientific phenomenon is an event or situation that is observed to exist or happen, especially one whose cause or explanation is in question. Sense-making is a conceptual process in which a learner actively engages with scientific phenomena to construct logical and coherent explanations that incorporate their current understanding of science and are consistent with the available evidence. To develop a scientific understanding of the natural and designed worlds, and to answer compelling questions in science, students must be able to:

- **Gather and analyze** information and sources
- **Synthesize claims and evidence** to support reasoning
- **Critically evaluate and revise** ideas and connect them to scientific principles and theories
- **Communicate** understanding and reasoning through a variety of methods or products

Disciplinary Literacy in Science

Disciplinary literacy in science focuses on how reading, writing, speaking, and listening are used to develop sense-making in science. It emphasizes the content knowledge, experiences and skills, and ability to acquire new knowledge that experts within science disciplines use to apply and generate new knowledge.

As students begin to develop disciplinary literacy in science, they use strategies to build background knowledge and experiences specific to science content and practices, learn specialized vocabulary, deconstruct complex text structures, map graphic and mathematical representations against explanations in text, pose discipline-specific questions, and provide evidence to support, evaluate, and communicate claims. As students develop disciplinary literacy in science, they strengthen their ability to think critically in a way that is meaningful to developing scientific understanding of the world and scientific habits of mind.



Reading Informational Text

Reading and interpreting scientific and technical text is critical to building knowledge in science and engineering. The 2016 ELA Standards provide the skills for students to do this. This section of the document illustrates ways science teachers can help students apply reading standards as they develop disciplinary literacy in science.

Key Ideas and Details	Using **Key Ideas and Details** to Build Disciplinary Literacy in Science
(Link to RI.1, RI.2, RI.3 for grades 3-5) These ELA standards help students gather and analyze sources and information (evidence from text) that can be used to support their reasoning as they develop conceptual understanding of science phenomena. Being able to read and interpret scientific and technical text is a fundamental practice of science and engineering.	Key Ideas and Details standards can be applied to help students: • Find answers to relevant science questions or problems. • Understand and follow a written lab protocol, scientific process, or procedure. • Connect new understandings with background knowledge. • Determine which information is important to answering scientific questions. • Pay attention to details, accuracy, and precision when reading/collecting data from scientific instruments. • Interpret diagrams, pictures, charts, graphs, and data to gather information. • Interpret and evaluate quality and quantity of data, evidence, and scientific reasoning. • Determine the credibility of information, including sample size and visual representations of data and findings.

Craft and Structure	Using **Craft and Structure** to Build Disciplinary Literacy in Science
(Link to RI.4, RI.5, RI.6 for grades 3-5) These ELA standards help students navigate the norms and conventions of science text. Scientific and technical text often contains a variety of text structures, visual representations, and vocabulary that has a very specific meaning. Reading text structures that embed bullets, graphs, data, images, captions, and non-linguistic representations of information is a fundamental practice of science and engineering.	Craft and Structure standards can be applied to help students: • Use strategies (context clues, restatement, examples, contrast, glossary, etc.) to determine the meaning of words and phrases in the text. • Use context to determine meanings of words and compare how vocabulary may be used differently in a science context compared to non-science contexts. • Identify structures within a text (headings, sub-headings, bold words, pictures, graphs, data tables, and paragraphs) and explain how they build on information in the paragraph text. • Explain how key terms relate to each other or to broader science concepts and general understanding. • Use information to answer questions and support reasoning and conclusions. • Make meaning out of mathematical symbols and equations; diagrams, or other visual representations and explain why the author used them instead of paragraph text.

Integration of Knowledge and Ideas	Using **Integration of Knowledge and Ideas** to Build Disciplinary Literacy in Science
(Link to RI.7, RI.8, RI.9 for grades 3-5) These ELA standards help students integrate scientific knowledge and ideas when obtaining, evaluating, and communicating information. Students integrate information to evaluate the validity and reliability of ideas, methods, claims, and designs. They use this knowledge to generate their own questions about scientific phenomena or to identify solutions to design problems.	Integration of Knowledge and Ideas standards can be applied to help students: • Use data and information from multiple sources, including lab investigations, to support a scientific explanation or solve a scientific problem. • Use multiple sources or formats of information related to the same science concept and explain whether these sources provide similar levels of detail or whether the information supports or contradicts each other. • Locate the claim, evidence, and reasoning in scientific explanations and arguments. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation • Convert visual representations (graph, chart, picture, etc.) of information into words; convert words into visual representations. • Evaluate whether an author's claim is supported by the evidence provided and whether that evidence is relevant to the reasoning of the claim or argument.

Range of Reading and Level of Complexity	Using **Range of Reading and Level of Complexity** to Build Disciplinary Literacy in Science
(Link to RI.10 for grades 3-5) This ELA standard requires that students engage with different lengths, structures, types, and complexities of science text, appropriate for their grade level. Reading science texts requires a set of discipline-specific skills and strategies. Science texts use scientific vocabulary and present information in multiple formats.	Implementation strategies for this standard are embedded in the previous reading examples. Students in science classrooms often read at different levels of proficiency, and even the same student may read at different levels based on text structures or format. Teachers should understand the complexity of the text provided to students and implement appropriate strategies to support student conceptual understanding of science phenomena.

Writing

Writing is a key means of engaging in argument from evidence and requires students to construct a convincing argument that supports or refutes claims for explanations about the natural world. Students use appropriate and sufficient evidence and scientific reasoning to defend and critique the validity and reliability of claims and explanations about the natural world, or methods for collecting data and evidence.

The 2016 ELA Standards provide the skills for students to assert and defend claims, show what they know about a subject, and convey what they have experienced, thought, and designed. This section of the document illustrates ways science teachers can help students apply writing standards as they develop disciplinary literacy in science. Scientific writing may include:

- informal writing (notes based on observations, summarizations of technical texts, making thinking visible by tracking how understanding of phenomena changes over time)
- formal writing (lab reports, documenting procedures, investigation designs, explanations of models, and research)
- persuasive writing (calls for action, letters to editors/policy makers, position statements)

Text Types and Purposes	Using **Text Types and Purposes** to Build Disciplinary Literacy in Science
(Link to W.1, W.2, W.3 for grades 3-5) These ELA standards help students write in formats that are typically found in science contexts or may be specific for their content area. Typically, only formal science writing is written in third person voice. In science, focus is shifted from stating personal opinions to using evidence to support an explanation or scientific argument. Students use evidence and reasoning to defend scientific claims and explanations, or methods for collecting data and evidence. It is critical that students know how to incorporate appropriate visual representations to support the scientific explanations and arguments they write.	Text Types and Purposes standards can be applied to help students: • Record thoughts, ideas, sketches, or collected data in science notebooks to be used as evidence or to support reasoning. • Write a claim, evidence-based argument, or explanation that includes logical reasoning, accurate science content, and relevant and sufficient evidence to support the claim. Claims are created with effective word choice, appropriate use of science vocabulary, and writing style. • Write formal or informal texts. The product may include notebook entries, research papers, laboratory notes or reports, functional text, or visual displays of data. • Produce science writing in a voice appropriate for the type of writing and the audience. Objective or academic voice in science is used when a writer wants to deliver information in a neutral, factual, and unbiased way. • Write step-by-step procedures for experiments that are detailed enough that others would be able to repeat the procedure and achieve the same results. • Produce texts that include charts, graphs, timelines, photographs, videos, maps, flowcharts, diagrams, models, or tables to supplement or support the text.

Production and Distribution of Writing	Using **Production and Distribution of Writing** to Build Disciplinary Literacy in Science
(Link to W.4, W.5, W.6 for grades 3-5) These ELA standards help students develop scientific writing appropriate for task, purpose and audience.	Production and Distribution of Writing standards can be applied to help students: • Develop and strengthen writing; focus on purpose and audience. • Incorporate peer or adult feedback of drafts into writing; the writing process and review of drafts can be used for any writing assignments within the science classroom. • Use technology (Internet, keyboarding skills, formatting, storing) to create a published piece where information and ideas are connected and presented clearly and efficiently. • Use technology (blogs, wikis, smartboards, apps) to support collaborative brainstorming and writing. • Integrate graphs, data tables, drawings or illustrations, or other visual representations of information to support text.

Research to Build and Present Knowledge	Using **Research to Build and Present Knowledge** to Build Disciplinary Literacy in Science
(Link to W.7, W.8, for grades 3-5 and W.9 for grades 4-5) These ELA standards help students synthesize multiple texts, observations, or experiments to answer questions, gather information, reason about the evidence, and communicate findings or conclusions. Final communication products typically follow a formal writing style (documenting or publishing procedures, investigation designs, explanations of models, and research) and are written in academic or third person voice.	Research to Build and Present Knowledge standards can be applied to help students: • Conduct research projects or experimental investigations of differing lengths to provide enough information to construct claims, evidence, and explanations that answer scientific questions or solve a problem. • Integrate information from a variety of credible print and digital sources, taking care to use a consistent voice and avoid plagiarism. • Use evidence from informational texts (e.g., encyclopedias, credible web sites, experts, news articles, textbooks, trade books) to support claims, analyses, reflections, and/or research. • Convert informal writing in drafts while still making sense of information and developing claims, to a formal academic voice when publishing formal writing of claims.

Range of Writing	Using **Range of Writing** to Build Disciplinary Literacy in Science
(Link to W.10 for grades 3-5) This ELA standard requires that students produce informal, formal, and persuasive scientific writing across multiple delivery formats and topics, for different purposes and audiences.	Implementation strategies for this standard are embedded in the previous writing examples. • Writing assignments should be of varying lengths (field or research notes, one paragraph responses, multiple paragraph essays, lab reports or presentations, extended research). • Scientific writing often includes pictures, diagrams, charts, thinking maps, data, or statistics; these can be integrated with text or presented with minimal text.

Speaking and Listening

Students must have ample opportunities to engage in science discourse across a variety of rich, conversations—as part of a whole class, in small groups, and with a partner. Being productive members of these conversations requires that students contribute accurate, relevant information; respond to and extend what others have said; make comparisons and contrasts; and analyze and synthesize a multitude of ideas in various domains. The 2016 ELA Standards provide the skills for students to do this. This section of the document illustrates ways science teachers can help students apply speaking and listening standards as they develop disciplinary literacy in science.

Comprehension and Collaboration	Using **Comprehension and Collaboration** to Build Disciplinary Literacy in Science
(Link to SL.1, SL.2, SL.3 for grades 3-5) These ELA standards help students engage in scientific discourse to gather and evaluate information. Engaging in scientific discourse communities to collaborate and build comprehension is a fundamental practice of science and engineering.	Comprehension and Collaboration standards can be applied to help students: • Initiate and participate effectively in a range of collaborative discussions (one-on-one, small groups, teacher-led, digitally) to express their own ideas clearly and building on others' ideas. • Integrate multiple sources of information presented in diverse media or formats (visually, quantitatively, orally), and explain how the information supports a claim, data analysis, reasoning, or conclusion. • Collaboratively plan or conduct investigations; determine whether the data is collected with appropriate tools, in a safe and ethical manner, and is consistent with other groups' findings. • Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions. • Refine explanations, arguments, or other science ideas based on feedback.

Presentation of Knowledge and Ideas	Using **Presentation of Knowledge and Ideas** to Build Disciplinary Literacy in Science
(Link to SL.4, SL.5, SL.6 for grades 3-5) These ELA standards help students engage in scientific discourse to informally share ideas and develop understanding of scientific phenomena and provide a formal way to present information appropriate to the audience and task. Engaging in scientific discourse communities to communicate understanding and findings is a fundamental practice of science and engineering.	Presentation of Knowledge and Ideas standards can be applied to help students: • Engage in science discourse with a partner or small group by discussing questions, information, results, and supporting evidence. Speak clearly and in a sequence so listeners can follow the line of thinking and reasoning. • Engage in formal presentations to small or large groups of students to share findings and supporting evidence. Presentation should be clear, concise, and logically organized; content and presentation style are appropriate to purpose, audience, and task. • Use digital media (graphics, images, music, sound, visual displays, or interactive elements) in presentations to clarify science content and to add interest. • Communicate scientific information orally, using various forms of media, tables, diagrams, and charts.

Annotated Vignette – Grade 3 Science

In a 3rd grade science class, students are learning that sound is a form of energy that travels in waves and that a vibrating source creates the wave (Strand 5 Concept 3). This lesson focuses on developing understanding that vibrating objects or materials make sound, and that sound can travel through different materials and media. Students work together to collect evidence that sound travels through solid, liquids, and gases. Subsequent lessons will focus on developing the ideas that sound is a form of energy that travels in waves.

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• SL= Gather information using comprehension and collaboration.	The teacher starts the lesson by telling students that they are going to hear several different sounds, and then makes the sounds – clapping, ringing a bell, dropping a book, and singing. Students are asked, **How do sounds get to your ears so you can hear them?** Students discuss their ideas in groups of two or three, and then the different ideas are shared with the whole class. The teacher makes a 3-column chart on the board, labeling each column as solid, liquid, or gas. Students are asked, **Can sounds go through solids, liquids, and gases to get to your ears so you can hear them?** Each student puts a check on the board under the column heading(s) that they think sound can travel through.
• RI= Follow instructions and lab procedures using key ideas and details • SL= Gather information about sound using comprehension and collaboration • W= Gather information and record observations using text types and purposes.	Students are given a 3-column recording sheet similar to what is on the board. They are told that they will be testing whether sound can travel through solids, liquids, and gases and collecting evidence. The sheet is to record any observations they make during their tests. The room is set up with several different stations to test how sound travels through different materials/matter. The stations provide opportunity for students to test sound through solids (tapping on the table with their ear against the table, connecting two cans with a string and talking through the cans like a phone) liquids (striking a tuning fork and placing it in a tub of water, holding a squeaky toy under water and squeezing it), and gas/air (talking out loud to somebody across the table, hitting a drum). Students move through the stations, following the written instructions/pictures, and record observations about when they could hear the sounds and anything else they noticed while listening to the sounds.
• SL= Synthesize claims and evidence using comprehension and collaboration • SL= Critically evaluate and revise using comprehension and collaboration	After completing the lab stations and recording their observations, students review the original 3-column chart and update their checkmarks on whether sound can travel through solids, liquids, and gases. For each type of matter, students provide evidence from their observation to support why they said yes (sound can travel through it) or why they said no (sound cannot travel through it)

• SL= Gather information using comprehension and collaboration.	After the class shows evidence that sound can travel through solids, liquids, and gases, the teacher goes back to the original question, **How do sounds get to your ears so you can hear them?**
• RI= Gather information on definitions using craft and structure. • RI= Follow instructions and lab procedures using key ideas and details. • SL= Gather information about sound using comprehension and collaboration. • W= Gather information and record observations using text types and purposes.	The teacher asks students to hum. As they are humming, the teacher demonstrates how to make "duck lips" while humming, and asks students to do the same. Students are asked if their lips feel different when they hum compared to when they stop humming. After students have time to describe what they feel, the teacher asks students to lightly touch the front of their neck as they hum. Again, students are asked if the feel anything different when they hum compared to when they are not humming. After the students describe what they feel, the teacher introduces and writes the definitions of the words **vibrate** and **vibration**. Students are then asked, **Is there always a vibration when there is sound?** Students return to the existing stations to see if they can detect vibrations at each, and record their observations. Additional stations are added for students to observe grains of rice on a speaker, a speaker set at high volume placed against the container of water, a stretched rubber band, and videos showing strings on musical instruments vibrating, and sound causing vibration in water.
• SL= Synthesize claims and evidence using comprehension and collaboration. • SL= Critically evaluate and revise using presentation of knowledge and ideas.	After completing additional observations, students decide whether there is always a vibration when there is sound. Students who answer yes, move to one side of the room, and students who answer no move to the other side of the room. The students on each side discuss their strongest evidence to support their claim. Each side of the room takes turns presenting their evidence and students can switch sides if they are convinced by the evidence of the other side.
• RI= Synthesize claims and evidence using integration of knowledge and ideas.	After 10-15 minutes of sharing their evidence, students read informational text, watch a video about sound, and use an online simulation that further shows that a vibrating source is needed to create sound.
W= Publish claims using production and distribution of writing.	In their science notebooks, students write a claim to answer the question**, Is there always a vibration when there is sound?** They use evidence from their observations, informational text, classroom discussion, and videos to support their claim. Students will have opportunity to revisit their claim in subsequent lessons as they further explore and relate vibrations to sound waves.

Annotated Vignette – Grade 4 Science

In a 4th grade science class, students are learning about energy, electricity, and magnetism (Strand 5 Concept 3). They have learned about electricity that occurs in nature as static electricity and lightning, and are now starting to learn about electrical circuits. This lesson focuses on helping students develop understanding of electrical circuits and how they are needed for a light bulb to turn on. In later lessons, students will build on this understanding as they learn about parallel and series circuits, and practical applications of circuits.

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• W= Communicate by writing initial ideas using text types and purposes • SL= Gather and analyze information using comprehension and collaboration.	The teacher flips the wall switch and turns on and off the lights. The students are asked the question, **When you flip the light switch, what happens that makes the lights turn on or off?** Students are directed to write or draw their understanding in their science notebooks. Students then talk in pairs, sharing their understanding with a partner.
• W= Communicate by drawing and labeling tested circuits using text types and purposes • W= Gather and analyze information by recording drawings using text types and purposes • SL= Gather and analyze information using comprehension and collaboration.	The teacher tells the students that they are going to test their ideas of what causes a light bulb to turn on or off. Each group of students receives a mini lightbulb, two wires, and a battery. Students are given the directions to use the materials to find as many ways (configurations) as they can to get the bulb to light, and to draw every configuration they tested to show what worked, and what didn't work. Students test their ideas on how to make the bulb light. Each student draws and labels each configuration (both working and nonworking) in their own science notebook, labeling the parts and whether the bulb lit.
• W= Communicate by drawing and labeling tested circuits using text types and purposes • RI= Gather information by interpreting drawings using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration. • SL= Synthesize claims and evidence using presentation of knowledge and ideas.	Each group of students selects one of their drawings (working or non-working) to draw on the board to share with the class. Once each group has their drawings on the board, students are asked to individually decide which drawings show a configuration where the bulb lit, and which drawings show a configuration where the bulb did not light. The teacher points to a drawing on the board and asks students who thought the bulb would light, to form an outer circle, and students who thought the bulb would not light to form an inner circle. Students are then instructed to talk to a partner in the opposite circle and explain their thinking about why the bulb did or did not light. After each drawing, the group that added that picture, are asked to say whether the bulb lit or not, and the teacher marks the answer on the board with the drawing. This is repeated until all unique configurations on the board are discussed.

• W= Synthesize claims and evidence by using text types and purposes.	Students are asked to come up with a claim about what is needed for a bulb to light and use evidence from their conversations and the drawings to support their claim. Students record their claim and evidence in their lab notebooks. Students are allowed access to the materials to test any of the configurations again as they are writing their claims.
• RI= Synthesize claims and evidence using key ideas and details from the text and video • RI= Synthesize claims and evidence using integration of knowledge and ideas from the text and video • SL= Synthesize claims and evidence using comprehension and collaboration from the video • W= Critically evaluate and revise using text types and purposes • W= Critically evaluate and revise using production and distribution of writing	The class reads a short piece of informational text from a web site or their text book explaining how circuits work, and showing a diagram of a simple circuit with each component labeled. They then watch a video explaining how electrical currents move through circuits to light a bulb. Students rewrite their claim and update any drawings and labels to include new vocabulary (circuit, electrical current, energy, conductor).

Annotated Vignette – Grade 5 Science

In a 5th grade science class, students learning about the Earth's place in the Universe and how the apparent shape or position of celestial objects change in regular patterns over time. Prior to this lesson, students have either seen time-lapsed videos of the moon or have recorded nightly observations of the Moon for a month. The goal of this lesson is for students to create models to explain why the apparent shape of the Moon changes.

Disciplinary Literacy Skills	Vignette of Student Activities During a Science Lesson
• W= Gather information and record observations using text types and purposes. • SL= Gather and analyze information using comprehension and collaboration.	The teacher asks students to share their observations about the shape of the moon (from video or month-long observations) and compare their observations with their classmates. As a class, the different shapes (phases) of the Moon that were observed are described and pictures of each phase are posted, showing a cycle.
• W= Share ideas using text types and purposes.	Students are asked **Why did it look like the shape of the Moon changed over time?** Students use their science notebooks to record their ideas. After individually recording their own ideas, the teacher provides a prompt that asks students which explanation best matches their ideas about what causes the changes (the prompt includes 5 statements: 4 common misconceptions and 1 scientifically accurate statement). Students write the number of the statement they most agree with on a sticky note, then post it on a class consensogram.
• RI= Gather and analyze information using key ideas and details. • SL= Gather and analyze information using comprehension and collaboration.	The teacher tells the students that they are going to create a model that can be used to test different ideas about why the moon looks different on different days. Each group is provided with an inflatable globe, a flashlight, and a white foam ball on a stick. Each group is provided time to explore the model to see if they can create the same pattern (phases) in the Moon's shape. Within each group, students negotiate how they will construct and test their model, how they will record observations, and what their observations mean.
• SL= Communicate understanding and reasoning using comprehension and collaboration. • SL= Gather and analyze information using comprehension and collaboration.	As students test their models, the teacher moves from group to group, observing what students are testing and listening to their thinking. The teacher asks guiding questions to help move the student thinking forward, or directs students to visit other groups for ideas or strategies.
• RI=Gather information using key ideas and details. • RI=Gather information using text types and purposes.	After each group has time to test their models and discuss their ideas, the teacher writes vocabulary that the students should learn (waxing, waning, names of phases). Students then use their textbook and a teacher-provided article to match the phases with the drawings of the phases.

• SL= Communicate understanding and reasoning using presentation of knowledge and ideas.	The teacher assigns each group with a phase of the moon. Each group then uses their model to demonstrate and explain the Moon's appearance during that phase. They present it to the class, with the rest of the class listening and asking questions and providing comments, as appropriate.
• SL= Critically evaluate and revise using using presentation of knowledge and ideas. • W= Critically evaluate and revise using text types and purposes. • W= Critically evaluate and revise using production and distribution of writing	At the end of the lesson, students revisit the original probe and label a new sticky note with the response that best explains why the appearance of the Moon changes over a month. The class constructs a new consensogram based on their updated thinking. Students revise the explanation in their science notebooks with their new thinking and with drawings that are properly labeled with the names of the phases.
	In a subsequent lesson, students will continue to work with their model to answer the question "Why do some months have 1 full moon and other months have 2 full moons?"